PB83-102780

Economic Impact Assessment for the National Ambient Air Quality Standard for Lead

(U.S.) Environmental Protection Agency
Washington, DC

22 Nov 77

U.S. Department of Commerce
National Technical Information Service
NTIS.

PB83-102780

ECONOMIC IMPACT ASSESSMENT FOR THE NATIONAL AMBIENT AIR QUALITY STANDARD FOR LEAD

Office of Air Quality Planning and Standards
Office of Air and Waste Management
U.S. Environmental Protection Agency

November 22, 1977

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SPRINGFIELD, VA 22161

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO.	2.	3. RECIPIENT'S ACCESSION NO. PB83 102780
4. TITLE AND SUBTITLE ECONOMIC IMPACT ASSESSMENT FOR THE NATIONAL AMBIENT AIR QUALITY STANDARD FOR LEAD		5. REPORT DATE November 22, 1977 6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S)		8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS Same as box 12.		10. PROGRAM ELEMENT NO. 11. CONTRACT/GRANT NO.
12. SPONSORING AGENCY NAME AND ADDRESS Office of Air Quality Planning and Standards Office of Air and Waste Management U.S. Environmental Protection Agency		13. TYPE OF REPORT AND PERIOD COVERED 14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES

16. ABSTRACT

This report assesses the cost and economic impact of alternative ambient lead standards. The stationary sources covered in the assessment are model primary lead smelters, secondary lead smelters, gasoline lead additive manufacturing plants, lead-acid bettery manufacturing plants, primary copper smelters, and grey iron foundries. In addition, the potential costs of mobile source emission control and of requisite state and local control agency information, administration, and enforcement activities for alternative standards are also estimated. The alternative standards considered are 2.0, 1.5, and 1.0 g/m3, monthly average. The detailed methodology and documentation of the analysis are provided in the report entitled "Background Document Supporting the Economic Impact Assessment of the Lead Ambient Air Quality i Standard."

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Air Pollution Lead Ambient lead standards - Cost Elad emission sources		EPA68A

18. DISTRIBUTION STATEMENT	19. SECURITY CLASS (This Report)	21. NO. OF PAGES
	20. SECURITY CLASS (This page)	22. PRICE

EPA Form 2220-1 (Rev. 4-77) PREVIOUS EDITION IS OBSOLETE

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ECONOMIC IMPACT ASSESSMENT

Chapter 1 Summary and Introduction

1.1 Summary

1.2 Introduction

Chapter 2 Stationary Source Assessment

2.1 Primary Lead Smelting

2.1.1 Industry Structure

2.1.2 Model Plant Specifications and Dispersion Model Results

2.1.3 Control Costs

2.1.4 Model Plant Closure Assessment

2.2 Secondary Lead Smelting

2.3 Primary Copper Smelting

2.4 Grey Iron Foundry Casting

2.5 Gasoline Lead Additives Manufacturing

2.6 Lead-Acid Battery Manufacturing

Chapter 3 Other Affected Sectors

3.1 Mobile Source Assessment

3.2 State and Local Control Agency Assessment

1.0 SUMMARY AND INTRODUCTION

1.1 Summary

The purpose of this analysis is to estimate the economic impact which can be expected from a constant air quality for lead. This analysis examines three levels which are deemed to fall within the likely range of the final standard. It should be noted, however, that this economic assessment is not a basis for selecting the standard since the Clean Air Act requires that the standard be based solely on health and welfare criteria. This assessment considers three possible standards: 1.0, 1.5, and 2.0 $\mu g/m^3$ (monthly average). The economic impact assessment emphasizes the impacts upon stationary source lead emitters but also discusses the impacts upon mobile source lead emitters and state and local control agencies charged with implementing the standard.

Dispersion models indicate that plants in at least six industries may be required to install control devices to meet the alternative standards under consideration. These control devices would be in addition to those control systems required by typical state regulations for control of particulate or other emissions. The six industries under consideration are primary lead smelting, secondary lead smelting, primary copper smelting, grey iron foundries, gasoline lead additive manufacturing, and lead-acid storage battery manufacturing.

The economic impact assessment is based primarily upon the use of model plants and estimated emission factors. The model plant emissions were used in a meteorological dispersion model that predicts maximum ambient lead concentrations. The dispersion modeling results were then used to estimate which emission sources needed additional control to meet the alternative ambient standards and the extent of control required. The resulting control requirement then determined the type of control equipment needed and the cost of the equipment. Control costs to meet alternative standards were

then factored into a discounted cash flow model that served as the basis for evaluating potential plant closures.

As expected, the results of the economic impact analysis indicate that model plants of the six industries mentioned above will be affected in varying degrees by the alternative standards under consideration. As shown in Table 1-1, annualized compliance costs expressed as a percent of model plant revenues range from zero to over 7 percent depending upon the level of the standard and the type of model plant being analyzed.

It is possible that some plants, facing control costs of the magnitude shown in Table 1-1, may choose to close rather than comply with emission regulations required to achieve a given ambient lead standard. An analysis of this issue shows that, for lead air quality standards of either 1.5 or 2.0 $\mu g/m^3$, potential plant closures may be possible in the primary lead industry, the secondary lead industry, and the primary copper industry. In addition, at an ambient standard of 1.0 $\mu g/m^3$ plant closures may be possible for some grey iron foundries. Plant closures are not projected for gasoline lead additive plants or lead-acid battery plants for any of the alternative standards under consideration.

The economic impacts described above are based upon a number of factors such as emission rates, plant profit margins, and terrain and weather conditions in the vicinity of the source. Since these variables are difficult to quantify with any reasonable degree of precision, it must be borne in mind that impacts at any one specific source may vary considerably from the impacts described here. It should be noted that a rollback analysis (an analysis that assumes a linear relationship between the percent of air quality improvement and emission reductions) indicated that only two industries-- primary lead smelting and

Table 1-1. RELATIVE COSTS OF ALTERNATIVE AMBIENT LEAD STANDARDS - MODEL PLANT ANNUALIZED COSTS AS A PERCENT OF ANNUAL REVENUE

Model Plant Type	Alternative Ambient Standards ($\mu g/m^3$ monthly average) 2.0	1.5	1.0
Primary Lead	0.9% to 7.7%*	1.2% to 7.7%*	1.8% to 7.7%*
Secondary Lead	7.4%**	7.4%**	7.4%**
Primary Copper	0.0% to 3.3%	0.0% to 4.3%	0.0% to 5.2%
Grey Iron	0.0% to 2.0%	0.0% to 3.8%	0.0% to 6.2%
Gasoline Lead Additives	0.2%	0.2%	0.2%
Lead Acid Batteries	0.0% to 0.1%	0.0% to 0.1%	0.0% to 0.1%

*The control efficiency of the costed system is assumed to be 95%. At this level of efficiency the model primary lead smelter with high fugitive emissions could only attain an air quality standard of 3.9 $\mu g/m^3$.

**The model secondary lead smelter with low fugitive emissions could meet a standard of 2.0 $\mu g/m^3$ with an expenditure of 7.4% using the 95% control system referred to above. A model secondary lead smelter with high fugitive emissions, however, could only meet an air quality level of 3.7 $\mu g/m^3$ with the same system.

primary copper smelting--would need to install control devices to meet the alternative standards. This result is at variance with the dispersion analysis upon which the stationary source economic impact assessment was based that indicated six industries would need to install control devices. This fact emphasizes the effect of various modeling assumptions upon the results of the economic impact analysis as well as the general problem of the variability of the results depending upon various input assumptions.

An analysis of potential impacts to mobile source lead emitters for the ambient lead standards under consideration has also been developed. This analysis indicates that mobile sources in portions of one to four Air Quality Control Regions, or a possible total of 58,000 to 1,300,000 vehicles, may have to be controlled, assuming the ambient lead standard must be achieved in 1982. However, because of lead phasedown regulations and the increased use of lead free gasoline for catalyst equipped vehicles, the total number of mobile source lead emitters is expected to decrease after 1982. One control device that may be feasible for mobile sources is a lead trap muffler. Other means of control include reducing vehicle miles traveled and further reducing the lead content of gasoline.

State and local air pollution control agencies will also incur costs to develop and implement plans to achieve an ambient air quality standard for lead. Total first year costs for all state and local agencies are estimated to range from $1.0 - $1.7 million, or 0.6 - 1.0 percent of current expenditures. Recurring costs are estimated to be $1.4 - $2.8 million, or 0.9 - 1.8 percent of current expenditures. Man-year requirements, both first-year and recurring, are similarly estimated to be less than 2 percent of current levels.

1.2 INTRODUCTION

This report assesses the cost and economic impact of alternative ambient lead standards. The stationary sources covered in the assessment are model primary lead smelters, secondary lead smelters, gasoline lead additive manufacturing plants, lead-acid battery manufacturing plants, primary copper smelters, and grey iron foundries. In addition, the potential costs of mobile source emission control and of requisite state and local control agency information, administration, and enforcement activities for alternative standards are also estimated. The alternative standards considered are 2.0, 1.5, and 1.0 $\mu g/m^3$, monthly average. The detailed methodology and documentation of the analysis are provided in the report entitled "Background Document Supporting the Economic Impact Assessment of the Lead Ambient Air Quality Standard".

1.2.1 Reasons for Selection of Sources for Consideration

In 1975, about 142 thousand metric tons of lead were emitted nationwide. Combustion of lead containing gasoline accounted for 90% of those emissions. Combustion of waste crankcase oil, solid waste, oil, and coal accounted for an additional 5% of national emissions in 1975. The remaining 5% came from 19 industrial stationary source types.[1] As a result of phasedown of lead in gasoline, lead emissions from gasoline combustion are expected to decrease about 60% by 1985 from current levels.[2] Although this is a large relative decline, gasoline combustion emissions are still projected to be the greatest emission source nationally in 1985. Because of this,

gasoline combustion sources (mobile sources) are included in the economic impact assessment.

Combustion of waste crankcase oil, solid waste, oil, and coal is not considered in the economic impact assessment.[3] Combustion of waste crankcase oil is not considered because the phasedown of lead in gasoline will cause combustion of waste crankcase oil to cease to be a major source. Combustion of solid waste is not considered in the analysis since many solid waste combustion facilities (i.e., municipal incinerators) are scheduled to be closed. Therefore, lead emissions from this source category will be substantially reduced. Finally, sources burning oil and coal are not considered since dispersion modeling and ambient data analysis near these sources have indicated that oil and coal combustion will probably not result in violations of any of the alternative ambient standards under consideration.

Growth projections as well as analyses of estimated emissions and measured ambient impacts were developed for the 19 industrial stationary source types previously mentioned. As a result, 8 of the 19 were identified as sources probably requiring additional emission control.[4] These 8 industrial source types are primary lead smelters, secondary lead smelters, primary copper smelters, gasoline lead additives manufacturing plants, lead-acid battery manufacturing plants, grey iron foundries, ferroalloy plants, and lead ore crushing and grinding plants. The economic impact assessment includes the first six of the aforementioned source types. Ferroalloy plants are not considered in the economic impact assessment because dispersion modeling indicated that emissions from a model ferroalloy plant in zero background-isolated

source situations should not result in violations of any of the alternative standards under consideration. Ore crushing and grinding plants are not considered in the economic impact analysis because of the inability to adequately measure fugitive emissions from these sources and also to predict the ambient impact of these emissions. These fugitive emissions are a function of particle density and wind speed. The density data is not currently available nor is a dispersion model which handles windblown emissions.

One assumption which tends to understate the economic impact of any given ambient lead standard is that each model plant is an isolated source with no background ambient levels of lead present. To the extent that sources of lead emissions may be clustered, the combined ambient lead concentrations of the cluster result in higher control costs and impacts than assumed.

In addition, even if the isolated source assumption were valid, there are other factors that influence the results of the economic impact analysis. These include topographical and meteorological conditions, stack characteristics, particulate emission factors, lead content and particle size of particulate, fugitive emissions factors, and baseline process economics. Values for many of these factors are initially specified as range estimates with midpoints (arithmetic means) of the ranges used in the model plant analysis. For other factors, values used in the model plant analysis are derived from site specific measurements. However, the degree of error in the measurement per se or in the application of the measured value to the model plant is not well known.

Variations in these data inputs (factors) among plants and source types limit the accuracy of the economic impact assessment. However, the assessment does explicitly address some variations via a reasonable range analysis for certain data inputs.

1.2.2 Methodology

1.2.2.1 Stationary Source Assessment Methodology

Plant, dispersion, control cost, and discounted cash flow models provide the bases for the economic impact assessment for the selected stationary sources. Outputs of the plant models include emission, size, process, and location characteristics. These are inputs to the dispersion model. The dispersion model provides maximum predicted concentrations and source contribution file estimates. The latter relate point and fugitive emissions generated by the plant to maximum predicted ambient concentrations. The outputs of the dispersion model are used together with control systems engineering and cost data to produce estimates of investment and annualized control costs. These estimates are the outputs of the cost model. They are used together with process economic data in the discounted cash flow models to produce a numerical estimate of the value of a plant after control. If these calculations show a plant is worth more closed than it is open, closure is predicted.

In situations where all control costs could be passed on without any effect on production levels, closure would never be predicted using the

aforementioned methodology. However, the ability of an individual plant to pass costs on and sustain pre-control production levels becomes less likely as alternatives to accepting the cost pass on become available to his customers or raw materials suppliers. The assumptions of the economic impact assessment and the competitive structure of the industries analyzed imply many alternatives to accepting a cost pass on. Consequently, no cost pass-on is considered in the closure analysis.

1.2.2.2 Mobile Source Assessment Methodology

A 1975 source emissions inventory and projected mobile and stationary source growth rates are used to estimate a 1982 lead emissions inventory for each Air Quality Control Region. In a similar manner, ambient concentrations are rolled forward. If the alternative ambient standards are predicted to be exceeded, the 1982 source emissions inventory and ambient concentrations are rolled back so that the standard is achieved. Of course, several different combinations of mobile and stationary source control can achieve the same rollback. In this analysis mobile source control is assumed used as a last resort and then with emission reduction effectiveness limited to 75%.

The 1982 stationary source emissions inventory used in the mobile source assessment includes eleven types of process sources. These are primary lead smelting, secondary lead smelting, primary copper smelting, grey iron production, gasoline lead additives production, lead-acid storage battery production, ferroalloy production, coal-fired power generation, oil-fired power generation, solid waste incineration, and iron and steel production. It is important to note that only primary lead smelting and primary copper smelting were projected to require additional rollback in 1982. This runs counter to the dispersion

model findings of the stationary source assessment which identify the first 6 of the 11 aforementioned sources as requiring further control. This apparent inconsistency is a function of the different methodologies employed and serves to underscore another source of variability. Moreover, like data variability, this inconsistency limits our ability to make accurate judgements regarding impact.

1.2.2.3 State and Local Control Agency Assessment Methodology

The state and local control agency assessment builds on the stationary and mobile source assessments. Control requirements for the stationary source model plant assessments for the three alternative standards are aggregated to a national level and used as inputs to EPA's Air Pollution Strategy Resource Estimator (APSRE). APSRE then provides an estimate of additional stationary source related state and local control agency needs. Additional resource requirements resulting from mobile source control are developed as supplementary calculations using the findings of the mobile source assessment.

2.1 PRIMARY LEAD SMELTING

2.1.1 Industry Structure

Six primary smelters owned by four corporations comprise the domestic industry. Company names, the plant capacities and locations are given in Table 2-1.

The four corporations smelting lead are both vertically and horizontally integrated. For example, they mine lead ore and refine smelted lead. In addition, they mine, smelt, and/or refine zinc, silver, coal, molybdenum, and copper. The dependence that these corporations have on lead varies, ranging from 6.1% of revenues for AMAX to 17.9% for Gulf Resources and Chemical.

Lead is an intermediate good. As such, the demand for lead is derived from the demand from lead-using products. These include batteries, gasoline lead additives, electrical cables and sheathing, paints, sheeting, plumbing, and ammunition. Through the year 2000, U.S. lead demand is projected to grow at 1.5% per year.[5]

Lead is a small percent of end product value and has few close substitutes. Therefore, its demand is characterizicterized as price inelastic.[6] This means that when lead prices increase, total revenue (price times quantity sold) increases.

Price inelastic demand notwithstanding, domestic primary smelters still could face competitive pressures from other lead suppliers. For example, unilateral price increases by domestic primary smelters could foster increased competition from domestic secondary producers. Also, unilateral price increases by domestic primary smelters could also foster increased competition from foreign producers. As indicated in Table 2-2, foreign producers' prices

Table 2-1. U. S. PRIMARY LEAD SMELTERS

Company	Plant(s) Location(s)	1974 Capacity (thousands of metric tons)
Amax	Boss, Missouri	127
ASARCO	East Helena, Montana	82
	El Paso, Texas	82
	Glover, Missouri	100
Gulf Resources & Chemical	Kellogg, Idaho	118
St. Joe Minerals Corp.	Herculaneum, Missouri	204
		713

Source: U.S. EPA, October 1974. Background Information for New Source Performance Standards: Primary Copper, Zinc, and Lead Smelters; Volume 1: Proposed Standards. Bureau of Mines Minerals Facts and Problems, 1975.

Table 2-2. LEAD PRICES

(Average annual price, cents per kilogram)

Year	London Metals Exchange	New York
1964	27.8	30.0
1965	31.8	35.3
1966	26.3	33.6
1967	22.7	30.9
1968	24.1	29.1
1969	28.9	32.9
1970	30.5	34.7
1971	25.4	30.7
1972	30.2	33.1
1973	43.0	36.0
1974	59.2	49.7
1975	41.5	47.5
1976	45.3	51.0

Source: Bureau of Mines, Mineral Facts and Problems, 1975.
Bureau of Mines, Minerals and Materials, December, 1976.
Bureau of Mines, Minerals Yearbook, 1970, 1972, 1974.

(London Metals Exchange) have been consistently less than domestic producers' prices (New York Exchange). Anticipated reaction by foreign producers to domestic primary smelter price increases may determine whether domestic smelters elect to absorb long run cost increases or push them forward as price increases.

2.1.2 Model Plant Specifications and Dispersion Model Results

The model plant specifications used in the economic impact assessment are primarily dependent on the assumptions and data requirements of the dispersion model. The dispersion model employed in the assessment is the Single Source (CRSTER) Model.[7] It is a steady state Gaussian plume dispersion model. CRSTER will be recommended to the states to develop lead emission regulations for isolated stationary sources.

Flat terrain is a basic assumption inherent in the CRSTER dispersion model, and hence is one of the model primary lead smelter's specifications. The flat terrain assumption may be important in predicting the distance of the maximum concentration from plant. The maximum concentration for the model primary lead smelter is predicted to be 300 meters away from the plant. With rugged terrain, the maximum concentration could be expected to be closer to the plant. A review of topographical maps for all six smelters indicates elevations greater than the smelter site within 300 meters of the plant. Consequently, the maximum concentration may occur closer to the plant than 300 meters.

Data requirements of the dispersion model include meteorological conditions such as wind speed, wind direction, and ambient temperature. Such data is not always available for every plant location. St. Louis meteorological data is available and is used in the analysis, since three of the six smelters are located near St. Louis.

Data requirements of the dispersion model also include emission characteristics such as stack gas exit velocity and temperature as well as point and fugitive emission rates and release heights. These emission characteristics are sometimes related to plant size. The production rate used in the dispersion modeling is 62 thousand metric tons annual production. This size is smaller than the current production rates of 4 of the 6 smelters. However, this size was chosen because fugitive emission measurements were available for a plant of that size. Furthermore, because emission characteristics are dependent on factors other than size, scaling up the fugitive emission measurements of the model plant to be consistent with an average plant size could provide atypical results.

The model smelter is assumed to have both stack and fugitive emissions of lead particulate. Stack emissions are assumed controlled to average SIP particulate allowable process weight rates. The fugitive emissions are assumed uncontrolled. These emissions come from the sinter machine building, blast furnace building, reverberatory furnace building, zinc fuming area, and the zinc furnace building.

Stack emissions from the model smelters have a negligible effect on predicted maximum ambient lead concentrations. Moreover, higher stack emission rates within a range thought to be reasonable do not change this finding.

Fugitive emissions have the predominent impact on predicted ambient concentrations, and this impact appears to vary significantly from smelter to smelter. For example, fugitive emission rates derived from measurements at a Montana primary lead smelter result in a maximum predicted concentration for the model smelter of 3.8 $\mu g/m^3$, monthly average. Fugitive emission rates derived from measurements at an Idaho smelter are higher and result in a maximum predicted concentration before control of 78.2 $\mu g/m^3$, monthly average.

2.1.3 Control Costs

2.1.3.1 Model Plant

The alternative ambient standards considered here are 2.0, 1.5, and 1.0 $\mu g/m^3$, monthly average. The predicted ambient concentrations from both sets of fugitive emission rates mentioned above are greater than the alternative standards. Hence, control costs corresponding to reduced fugitive emission rates which achieve the alternative ambient standards should be developed for the model primary lead smelter. Control costs representing the least costly means of achieving the three standards were developed for the lower set of derived fugitive emission rate. For the higher set, control costs corresponding to 95% control efficiency were developed. The 95% estimate is an engineering judgement based on the best demonstrated control system currently available (building evacuation to a fabric filter). However, 95% control applied to the higher set of fugitive emission rates still results in a predicted maximum concentration of 3.9 $\mu g/m^3$ which exceeds any of the alternative standards. The control efficiencies required to get to 2.0, 1.5, and 1.0 $\mu g/m^3$, respectively, are estimated to be 97.4%, 98.1%, and 98.7% as compared with 95% which is judged to be the maximum attainable.

The absolute and relative magnitude (as a percent of annual revenue) of the developed investment and annualized costs are presented in Table 2-3. For the lower fugitive emission rates, relative annualized control costs range from 0.9% to meet a standard of 2.0 $\mu g/m^3$ to 1.8% to meet a standard of 1.0 $\mu g/m^3$. For the higher fugitive emission rates, relative annualized costs are 7.7% to meet an ambient level of 3.9 $\mu g/m^3$.

2.1.3.2 Industry

The most critical factor in the model plant control cost assessment is the fugitive emission rates. As indicated previously, these rates have been derived from fugitive emission measurements at two of the six currently existing primary lead smelters. However, site specific topographical, meterological, and smelter size, configuration, and emission rates data are required to assess the ambient and cost impact at these six smelters with reasonable certainty. Assuming all primary lead smelters have the same site specific characteristics as the model smelter, five of the six existing smelters would probably have low fugitive emission rates and hence have ambient impacts closer to 3.8 than to 78.2 $\mu g/m^3$, monthly average. For three (the Missouri smelters) of the five smelters this judgement is based primarily on the presumption that since these smelters are newer they are better controlled. For the other two of the five smelters (Montana and Texas), similarity to the hypothetical smelter in terms of size, lower measured fugitive emissions, and/or lower measured ambient concentrations is the basis for the judgement. Higher measured fugitive emission and ambient concentrations are the reasons for classifying the Idaho smelter (the sixth smelter) as having ambient impacts closer to 78.2 $\mu g/m^3$.

Table 2-3. CONTROL COSTS FOR THE MODEL PRIMARY LEAD SMELTER

	Maximum Predicted Ambient Levels ($\mu g/m^3$, monthly average)			
	3.9	2.0	1.5	1.0
Higher Fugitive Emission Rates				
Investment 000's of $	10800	*	*	*
as a % of annual revenue	34.4%	*	*	*
Annualized Cost 000's of $'s	2400	*	*	*
as a % of annual revenue	7.7%	*	*	*
Lower Fugitive Emission Rates				
Investment 000's of $'s	0	1300	1600	2400
as a % of annual revenue	0	4.0%	5.2%	7.5%
Annualized Cost 000's of $'s	0	300	400	600
as a % of annual revenue	0	0.9%	1.2%	1.8%

*The control efficiency of the best demonstrated control system is limited according to engineering judgement to 95%. This is not sufficient to achieve the alternative ambient standards for the model plant with higher fugitive emission rates.

To draw further inferences from the model plant assessment is tenuous. However, assuming production is proportional to the number of smelters in each category and the model smelter costs can be extrapolated linearly to higher production volumes, industry control cost estimates can be developed. For 83.3% of the industry (current production share at the five plants assumed to have low fugitive emission rates), the respective investment costs in 1982 for meeting the 2.0, 1.5, and 1.0 $\mu g/m^3$ standards are $11.9 million, $15.3 million, and $22.4 million. The corresponding annualized costs are $2.8 million, $3.5 million and $5.3 million. For the remaining 16.7% of the industry (current production share of the other smelter), control cost estimates are those corresponding to 95% control efficiency. They are $20.5 million for investment and $4.6 million for annualized costs.

2.1.4 Model Plant Closure Assessment

Using a discounted cash flow analysis technique, synthesized model plant process economics, the aforementioned control costs, and assuming no other lead emitters in the vicinity, the potential for closing the smelter on financial grounds is assessed. Process economics (e.g., revenues, costs) were developed using Bureau of Mines data as well as financial data from specific companies.

Given the lower set of derived fugitive emission estimates, the model smelter should not close regardless of the level of the standard. This finding is true for several sets of circumstances. They include a range of marginal tax rates and minimum acceptable return rates thought to be reasonable, full

absorption of control costs, low profit margin and fully depreciated smelter, and full absorption of operation and maintenance cost required for the proposed Occupation Safety and Health Administration Lead Standard (100 $\mu g/m^3$, 40 hour time weighted average and 60 µg/100 g whole blood).

Given the higher set of derived fugitive emission estimates, the ability of the model smelter to achieve maximum (95%) control of fugitive emissions (assuming this amount of control is satisfactory) and remain open is unclear. The critical factors among previously described set of circumstances are the marginal tax rates and the minimum acceptable return rates. Marginal tax rates are the rates applicable to plant and not, for example, to the parent firm. Minimum acceptable return rates are the profits available from the next best investment opportunity. If the minimum acceptable return rates are not realized, the plant will close; and, the next best investment opportunity will be capitalized. If the tax and return rates are on the high end of the range thought to be reasonable, it would be in the best financial interest of model smelter to close. If the rates are lower, the model smelter with higher fugitive emission rates should make the expenditures to achieve 95% control and remain open.

2.2 SECONDARY LEAD SMELTING

2.2.1 Industry Structure

The secondary lead smelting industry is a subset of the secondary lead industry. The latter includes melters as well as smelters. Unfortunately, industry structure statistics are only available for the secondary lead industry.

The secondary lead industry in the United States supplied 545,000 metric tons or 39 percent of total lead consumption in 1974. Approximately 90 companies operating 130 plants produce lead and lead alloys for industrial use from recycled materials, principally old batteries.[8] Two companies, NL Industries, Inc., and RSR Corporation, operating about 18 secondary plants, account for over 50 percent of the total secondary lead production.[9] Thirteen other companies operating approximately 24 plants that manufacture storage batteries and other metal products account for 45 percent of secondary lead production.[10]

Roughly two-thirds of all lead produced at secondary smelters is antimonial lead and goes into the manufacture of batteries. Therefore, demand for secondary lead in the future is tied to growth in battery use. While new, longer lasting batteries are becoming more and more popular, demand for replacement batteries is still expected to be 35 percent of total demand each year until the end of the decade.

Prices are a critical factor in determining the supply of secondary lead. Primary lead prices affect secondary lead prices in a direct way. To the extent that the secondary industry acts as a broker, any change in the price of primary lead will be reflected in the price of scrap. Secondary producers,

therefore, could expand or contract their collection effort depending on changes in the price of lead. Although it may vary above and below the primary lead price, the secondary soft lead price follows the average prices quoted in Metals Week. Historical primary lead prices are provided in Table 2-2.

2.2.2 Model Plant Specifications and Dispersion Model Results

To provide reasonably accurate predictions of ambient impact, the model plant specifications should be consistent with the assumptions and data requirements of the dispersion model. CRSTER, the dispersion model employed in the assessment, is designed to predict ambient impacts of emissions from a plant located in flat terrain with meteorological conditions representative of the area. To avoid modeling an atypical situation, an actual smelter located in flat terrain with local meteorological data available is the plant modeled. The smelter produces about 30 metric tons of lead a day. However, this is somewhat low when compared to the midpoint of the range of plant sizes specified in the Control Techniques Document worksheets. The range specified there is 18 to 68 metric tons per day with the midpoint being 43 metric tons per day. But the actual size distribution of the secondary lead smelters is unknown. Moreover, an explicit attempt is made to avoid modeling atypical situations. Hence, the size of the model plant is not adjusted upwards to reflect the midpoint of a size range.

The model smelter has lead particulate stack emissions controlled to average SIP process weight rates. These emissions have a negligible impact on the maximum predicted ambient concentrations. In addition there are

fugitive emissions assumed for the model smelter. These emissions are uncontrolled and result in a maximum predicted concentration of 56.6 $\mu g/m^3$, monthly average for the midpoint (arithmetic mean) fugitive emission estimate. For a low fugitive emission estimate the maximum predicted concentration is 33.2 $\mu g/m^3$. For a high fugitive emission estimate the maximum predicted concentration is 80.5 $\mu g/m^3$. The maximum predicted concentrations for all fugitive emission estimates are extremely sensitive to the assumed release height of the fugitive emissions. For example, increasing the release height by 5 meters for the midpoint emission estimate reduces the maximum predicted concentration from 56.6 $\mu g/m^3$ to 20.0 $\mu g/m^3$. However, the release height assumed originally (10 meters) is thought to be typical of secondary lead smelting release heights.

If the release height is typical and best demonstrated control cannot achieve the standard, another consideration might be land acquisition. The predicted maximum of 56.6 $\mu g/m^3$ occurs 150 meters from the plant. If legally feasible and cost effective, the plant may supplement the fugitive emission control system by purchasing surrounding land which has ambient concentrations greater than the standard. Under such a strategy, and with barriers to limit access to these areas, the public would still be protected from the adverse consequences of concentrations exceeding the standard. However, the feasibility of land acquisition as a control strategy is beyond the scope of this assessment.

2.2.3 Control Costs

As previously noted, the maximum predicted concentrations of 33.2 to 80.5 $\mu g/m^3$, monthly average exceed the considered alternative ambient standards for all sets of fugitive emission estimates. Consequently, fugitive emissions will have to be reduced to some degree at the model smelter regardless of the level of the standard. Building evacuation to a fabric filter has been applied to secondary lead smelters before. However, the achieved level of control efficiency is not known. At present, 95% control efficiency seems to be the limit applied by engineering judgement on this technically demonstrated system.

Applying a 94% or 95% efficient control system to the model smelter is estimated to require an investment of $1.8 million which is about 32% of annual revenue. Corresponding annualized cost is $0.4 million which is about 7% of annual revenue. A 94% or 95% control efficiency will achieve the 2.0 $\mu g/m^3$ standard for the low fugitive emission estimates, but will not achieve any of the more restrictive alternative ambient standards. Furthermore, 95% control efficiency will not achieve any of the considered alternative ambient standards given the dispersion modeling results for the midpoint and high fugitive emission rate estimates. With the midpoint fugitive emission rate estimate, 95% control efficiency results in a predicted maximum of 2.8 $\mu g/m^3$. With the high fugitive emission rate estimate, 95% control results in a predicted maximum of 4.0 $\mu g/m^3$.

2.2.4 Model Plant Closure Assessment

The model plant closure assessment for secondary lead smelting includes

an analysis of high, average, and low profit margin smelters. The process economics (e.g., revenues, costs) for these profit margins are developed using publicly available financial data on NL Industries and RSR.

High profit margin model smelters with plants that are not fully depreciated should be able to absorb the costs associated with the 94% or 95% efficiency system and remain open. This finding holds within a range of marginal tax rates and minimum acceptable return rates thought to be reasonable. However, high profit margin model smelters that are fully depreciated will only be able to remain open under similar conditions if they have relatively low marginal tax rates and minimum acceptable return rates.

Average profit margin model smelters not having fully depreciated plants should be able to absorb the costs associated with the 94% or 95% efficiency system and remain open under most conditions. However, with a 94% efficiency system, this model smelter will close if the marginal tax rates and minimum acceptable return rates are reasonably high. With a 95% efficiency system, this model smelter will close if the minimum acceptable return rate is reasonably high and the marginal tax rate is within a range thought to be reasonable.

Low profit margin model smelters regardless of the depreciation circumstances and average profit margin model smelters that are fully depreciated would probably close rather than absorb the cost of a 94% or 95% efficiency system.

2.3 PRIMARY COPPER SMELTING

2.3.1 Industry Structure

Eight companies with a combined total of 16 smelters make up the U.S. primary copper smelting industry. Table 2-4 lists the companies, plants, their locations, and capacities.

Smelting is an intermediate production process preceeding refining and fabrication and following mining, ore beneficiation, and/or scrap collection. Consequently, the demand for smelted copper is derived from the demand for refined and fabricated copper. Refined and fabricated copper is used primarily by the construction, communications, and motor vehicle manufacturing industries. Substitutes for refined and fabricated copper do exist. They include aluminum, steel, and plastic.

Smelted copper can be supplied by secondary or primary producers either located in the U.S. or elsewhere. Foreign producers supplied about 10% of the 1974 U.S. demand for copper.[11] Domestic producers on the other hand used about 4% of the 1974 production to satisfy foreign demand for copper.[12] Of the domestic production used to satisfy domestic demand in 1974, about 45% was supplied by domestic secondary producers with the remaining 55% being supplied by primary producers.

Historical prices for domestic producers refined copper are presented in Table 2-5.

The demand for domestic primary smelting output is projected to grow at 3% per year.[13] However, limited domestic smelter capacity could constrain this growth resulting in excess demand and upward price pressures for blister, refined, and fabricated copper. Given future excess demand and upward price

Table 2-4. PRIMARY COPPER SMELTERS

Company	Smelter Location	1974 Smelter Capacity Furnace Charge (metric tons/yr)
The Anaconda Company	Anaconda, Montana	680,000
ASARCO	El Paso, Texas	523,000
	Hayden, Arizona	871,000
	Tacoma, Washington	544,000
Cities Service Corp.	Copper Hill, Tenn.	68,000
Copper Range	White Pine, Michigan	82,000[a]
Inspirational Consolidated Copper	Miami, Arizona	408,000
Kennecott Copper Corp.	Hayden, Arizona	381,000
	Hurley, New Mexico	363,000
	McGill, Nevado	363,000
	Garfield, Utah	907,000
Newmont Mining Corp.	San Manuel, Arizona	726,000
Phelps Dodge	Ajo, Arizona	227,000
	Douglas, Arizona	635,000
	Morenci, Arizona	816,000
	Hildago, New Mexico	91,000

[a]Measured as copper product.

Source: Background Information for New Source Performance Standards: Primary Copper, Zinc, and Lead Smelters - Volume I - Proposed Standards. U.S. EPA, Document No1 EPA-450/2-74-002a, October 1974, p. 6-3. Also ADL estimates for the EPA-MBO Study, forthcoming 1977.

Table 2-5. COPPER PRICES
(average annual price, cents per kilogram)

Year	F.O.B. Domestic Primary Producer Refined Price[a]
1964	70.5
1965	77.2
1966	79.8
1967	84.2
1968	92.2
1969	104.7
1970	127.2
1971	113.3
1972	111.6
1973	129.9
1974	168.9
1975	140.0
1976	151.7

[a]Source: Metals Week

pressures, domestic smelters will probably find it better to push forward any increases in production cost. The alternative, pushing the costs back to the ore and matte suppliers, could spell the loss of critical raw materials from marginal ore and matte suppliers. However, if only one domestic smelter is faced with production cost increases, it may find it difficult to pass them forward because of dependence on other domestic smelters following its lead. Passing production costs forward becomes much more plausible, however, if all or several domestic smelters incur similar production cost increases.

2.3.2 Model Plant Specifications and Dispersion Modeling Results

As mentioned in the primary and secondary lead smelting assessments, the requirements of the dispersion model affect the specifications of the model plant. Terrain and meteorological conditions are the two major influences. In essence, the model plant should be located in flat terrain with nearby meteorological condition data available. Furthermore, to be typical, the size and location of the model plant should correspond to an actual plant.

The model smelter is located in flat terrain, has Tucson, Arizona meteorological conditions, and has furnace charge capacity of 635,000 metric tons per year. These specifications do correspond to an actual plant. Moreover, some of the other existing smelters do have similar characteristics. For example, 5 of the 16 are located in flat terrain and 6 have meteorological conditions similar to Tucson, Arizona.

The charge rate of the model smelter is high when compared to the industry average of 500,000 metric tons per year. However, no existing smelters of that charge rate are located in flat terrain with nearby meteorological condition data available. Consequently, the model smelter size was not scaled up to the industry average.

Other model plant specifications include the process equipment. These specifications are for an actual plant with the aforementioned terrain, meteorology, and size characteristics. The model plant has a reverberatory smelting furnace, Pierce-Smith converters, and multiple hearth roasters. Of the 16 existing smelters, 12 have reverberatory smelting furnaces and 15 have Pierce-Smith converters. However, only four have multiple hearth roasters. The others have either fluidized-bed roasters or no roasters at all. The effect of process equipment variations among smelters on ambient air quality is presently unknown.

The model smelter is assumed to have both stack and fugitive emissions of lead particulate. Stack emissions are assumed controlled to average SIP particulate allowable process weight rates. The fugitive emissions are assumed uncontrolled and to emanate from the roaster, reverberatory furnace, and converter buildings.

Stack emissions have a negligible predicted impact on ambient lead concentrations. Moreover, higher emission rates within a range thought to be reasonable do not change this finding. Fugitive emissions do have a noticeable predicted ambient impact. However, fugitive emission estimates are dependent on the percent lead content of the materials handled. This

percentage varies among smelters. The fugitive emission estimates felt to be most typical of a middle estimate result in a predicted maximum ambient concentration of 3.1 $\mu g/m^3$, monthly average. The fugitive emission estimates felt to represent a reasonable lower limit on the percent lead content yield a predicted maximum ambient concentration of 0.4 $\mu g/m^3$, and, estimates for a reasonable higher limit result in a maximum predicted concentration of 10.7 $\mu g/m^3$, monthly average.

2.3.3 Control Costs

2.3.3.1 Model Plant

As indicated above, the monthly maximum predicted ambient concentration for the middle and reasonable higher limit fugitive emission estimates exceed the alternative ambient standards (2.0, 1.5, and 1.0 $\mu g/m^3$) at the model smelter. Consequently, control costs corresponding to reduced fugitive emission rates which will achieve the alternative ambient standards are developed. These costs are specifically designed to approximate the least cost means of achieving each standard. No costs are developed for the reasonable lower limit fugitive emission estimates since the predicted maximum concentration in that case is less than all considered alternative standards.

The investment, annualized control cost, and investment and annualized cost as a percent of annual revenue for the model smelter are presented in Table 2-6. The middle fugitive emission estimates investment costs range from \$5.2 million for the 2.0 $\mu g/m^3$ standard to \$9.8 million for the 1.0 $\mu g/m^3$ standard. The corresponding annualized costs range from \$1.1 million to \$2.1 million. With the reasonable higher limit fugitive emission estimates,

Table 2-6. CONTROL COSTS FOR THE MODEL PRIMARY SMELTER

	Maximum Predicted Ambient Levels ($\mu g/m^3$ monthly average)		
	2.0	1.5	1.0
Reasonable Higher Limit Fugitive Emission Rates			
Investment			
000's of $'s	22,300	28,900	35,400
as a % of annual revenue	15.2	19.7	24.2
Annualized Cost			
000's of $'s	4,800	6,200	7,600
as a % of annual revenue	3.3	4.3	5.2
Middle Fugitive Emission Rates			
Investment			
000's of $'s	5,200	7,600	9,800
as a % of annual revenue	3.5	5.2	6.7
Annualized Cost			
000's of $'s	1,100	1,600	2,100
as a % of annual revenue	0.8	1.1	1.4
Reasonable Lower Limit Fugitive Emission Rates	0*	0*	0*

*Investment and annualized costs are zero since the maximum predicted concentration is less than all considered alternative ambient standards.

corresponding investment costs range from $22.3 million to $35.4 million. The annualized cost range from $4.8 million to $7.6 million.

2.3.3.2 Industry

A critical factor in drawing inferences from the model plant assessment and applying them to the entire industry is the amount of control required. To determine the amount of control required necessitates categorizing existing smelters as indicative of the middle, reasonable lower, or reasonable higher limit fugitive emission estimates. On the basis of the estimated amount of lead in the furnace charge at full capacity, three existing smelters are believed to be indicative of the middle fugitive emission estimate; seven are indicative of reasonable lower limit fugitive emission estimate; and six are indicative of the higher limit fugitive emission estimate. To draw further inferences is tenuous. However, if it is assumed that production is proportional to the number of smelters in each category and the model smelter costs can be extrapolated linearly to higher production volumes, industry control cost estimates can be developed. The investment costs for the year 1982 are $184.4 million for a standard of 2.0 $\mu g/m^3$, $241.8 million for a standard of 1.5 $\mu g/m^3$, and $298.7 million for a standard of 1.0 $\mu g/m^3$. The corresponding annualized costs are $40.0 million, $52.3 million, and $64.4 million.

2.3.4 Model Plant Closure Assessment

Using a discounted cash flow analysis technique and model plant process economics synthesized from publicly available company financial reports, the potential for closing the smelter on financial grounds is assessed. Given the reasonable lower limit fugitive emission estimates, the model plant should not close. With a maximum predicted concentration of 0.4 $\mu g/m^3$, no control

expenditures are required. Given the middle fugitive emission estimate, the model smelter should not close even though control costs must be expended to achieve all alternative standards. This finding is true for a range of marginal tax rates and minimum acceptable return rates thought to be reasonable, full absorption of all control costs, and a fully depreciated model plant.

Given the reasonable higher limit fugitive emission estimates, the ability of the model smelter to remain open on financial grounds alone is unclear. However, the potential for remaining open is greater with a standard of 2.0 $\mu g/m^3$ than with either a standard of 1.5 or 1.0 $\mu g/m^3$. With a standard of 2.0 $\mu g/m^3$ certain marginal tax rate and minimum acceptable return rate combinations within a range thought to be reasonable do permit a fully depreciated plant absorbing all the control costs to remain economically viable. With the 1.5 or the 1.0 $\mu g/m^3$ standards, a fully depreciated plant absorbing all the control cost is not economically viable under any marginal tax rate and minimum acceptable return rate combinations judged to be reasonable.

2.4 GREY IRON FOUNDRY CASTING

2.4.1 Industry Structure

There are about a 1000 establishments classified as grey iron foundries.[14] Grey iron is produced at these foundries in cupola, electric, and reverberatory furnaces. The main output of the foundries is castings. These come in a variety of sizes and shapes having different chemical and physical properties.

The grey iron foundry industry produces intermediate goods. Castings become part of and/or are used in the production of automobiles and trucks, construction machinery, railway equipment, electrical and farm machinery, rolling mills, and machine tools. Consequently, the demand for grey iron is a function in part of the demand for these products. Demand for grey iron is projected to grow at 3.2% per year.[15]

Historically, the average price of grey iron castings has risen slightly faster than the Wholesale Price Index. However, what product that average price represents is not clear. The selling price for grey iron varies depending on the size, shape, and chemical and physical properties of the product. In 1976 the average price of a grey iron casting was $340/metric ton.[16]

2.4.2 Model Plant Specifications and Dispersion Modeling Results

The model foundry specifications are consistent with the assumptions and data requirements of the dispersion model. For example, the model grey iron foundry is located in flat terrain with representative meteorological condition data available. The model foundry specifications are also consistent with the objective of modeling a realistic situation. For example, like 60% of the grey iron foundry establishments, the model smelter is located in an east north central state.[17] Moreover, like 70%

of the grey iron produced nationally, the model foundry produces grey iron in a cupola furnace.[18] In addition, the size of the model foundry, 7.3 metric tons/hour melt rate, corresponds to an actual foundry located in flat terrain in an East North Central State.

The model smelter has lead particulate stack emissions controlled to average SIP process weight rates for particulate. Stack emissions have a negligible impact on the maximum predicted ambient concentrations. Fugitive emissions are assumed for the model grey iron foundry. These emissions are assumed uncontrolled. For a low fugitive emission rate estimate, the maximum predicted concentration is 0.3 $\mu g/m^3$, monthly average. For a midpoint fugitive emission rate estimate, the maximum predicted concentration is 1.8 $\mu g/m^3$. And, for a high fugitive emission rate estimate, the maximum predicted concentration is 3.7 $\mu g/m^3$, monthly average.

2.4.3 Control Cost

No control costs need to be developed for the low fugitive emission rate estimate since the predicted monthly average maximum concentration of 0.3 $\mu g/m^3$ is less than any of the alternative standards (i.e., 2.0, 1.5, and 1.0 $\mu g/m^3$). For the midpoint fugitive emission rate estimate control costs are developed for the 1.5 and 1.0 $\mu g/m^3$ alternatives since the predicted maximum (1.8 $\mu g/m^3$) is greater than these levels. However, no control costs are developed for the 2.0 $\mu g/m^3$ alternative since the predicted maximum is less. For the high estimate, since the predicted monthly average maximum of 3.7 $\mu g/m^3$ is greater than the three considered alternative standards, control costs are developed for all three standards.

The investment, annualized costs, and investment and annualized costs as a percent of annual revenue are presented in Table 2-7. The control system costed is side draft and canopy hoods which are ducted to a fabric filter. For the midpoint fugitive emission rate estimate, investment cost as a percent of annual revenue is 9.8% for both the 1.5 and 1.0 $\mu g/m^3$ standards. Annualized cost as a percent of annual revenue for both standards is 2.0%. The reason the costs do not vary between the 1.5 and 1.0 $\mu g/m^3$ standards is that the control system costed is assumed incapable of distinguishing between the required control efficiencies needed to attain both standards.

For the high fugitive emission rate estimate, the required control efficiencies for the 1.5 and 1.0 $\mu g/m^3$ standard are greater than for the midpoint fugitive estimate. These greater efficiencies are assumed reflected in different control system design and operating needs, and hence in the cost. Investment cost as a percent of annual revenue ranges from 9.8% for the 2.0 $\mu g/m^3$ standard to 30.4% for the 1.0 $\mu g/m^3$ standard. Corresponding annualized cost as a percent of annual revenue ranges from 2.0% to 6.2%.

2.4.4 Model Plant Closure Assessment

The baseline process economics for the grey iron foundry model plant are developed using financial data contained in Leo Troy's 1977 Almanac of Business and Industrial Financial Ratios.

Assuming zero background concentrations of lead and no other lead emitters in the area, the model grey iron foundry with low or midpoint fugitive emission rates should remain open regardless of the level of the standard. For the model with low fugitive emission rates, no control costs need be expended since all alternative standards are predicted to be achieved.

Table 2-7. CONTROL COST FOR THE MODEL GREY IRON FOUNDRY PLANT

	Maximum Predicted Ambient Levels ($\mu g/m^3$ monthly average)		
	2.0	1.5	1.0
High Fugitive Emission Rates			
Investment			
000's of $'s	300	600	1100
as a % of annual revenue	9.8%	18.4%	30.4%
Annualized Cost			
000's of $'s	70	130	220
as a % of annual revenue	2.0%	3.8%	6.2%
Midpoint Fugitive Emission Rates			
Investment			
000's of $'s	0*	300	300
as a % of annual revenue		9.8%	9.8%
Annualized Cost			
000's of $'s	0	70	70
as a % of annual revenue	0	2.0%	2.0%
Low Fugitive Emission Rates	0*	0*	0*

*Investment and annualized costs are zero since the maximum predicted concentration is less than all considered alternative ambient standards.

Hence, it is clear that the model foundry should remain open. For the model with midpoint fugitive emission rates, no control cost expenditures are required for the 2.0 $\mu g/m^3$ standard. However, the model foundry must expend control costs to achieve the 1.5 $\mu g/m^3$ and 1.0 $\mu g/m^3$ standards. Given that these costs must be absorbed, the model foundry is fully depreciated and the foundry faces a reasonable range of marginal tax and minimum acceptable return rates; it should remain open on financial grounds.

The model foundry with high fugitive emission rates requires control expenditures for all alternative standards. For the 2.0 and 1.5 $\mu g/m^3$ standard, the model foundry should remain open on financial grounds given the cost absorption, depreciation, and marginal tax and return rate conditions mentioned previously. However, with the 1.0 $\mu g/m^3$ standard, a fully depreciated foundry absorbing the control costs should close for most marginal tax rate and minimum acceptable return rates within a range thought to be reasonable. Only with marginal tax and minimum acceptable return rates at the low end of the reasonable range will a fully depreciated model foundry absorb the control costs needed to meet a 1.0 $\mu g/m^3$ standard and remain open on financial grounds.

2.5 GASOLINE LEAD ADDITIVES MANUFACTURING

2.5.1 Industry Structure

Four companies with a combined total of six plants comprise the U.S. gasoline additives (lead alkyl) industry. Table 2-8 lists the companies, their plants, capacities, and locations. Present annual capacity is 403 million kilograms of tetraethyl lead (TEL) equivalent. Annual production in 1974 was about 318 million kilograms of TEL equivalent or about 80% of capacity.[19]

Gasoline lead additives are mixed with gasoline to raise the Octane Number and consequently, reduce engine knock. Low production cost and high effectiveness in raising the Octane Number resulted in widespread use of lead additives with little competition from other compounds.

However, EPA's lead phasedown regulations will result in the development and acceptance of other compounds and hence, slow down future domestic production and consumption of gasoline lead additives.[20] Although most analysts agree the future U.S. production of lead additives will be less than it is today, the exact decline in future production is unknown. Industry representatives are optimistic with regard to export possibilities even though domestic consumption will decline.[21] However, others feel the export market growth may not materialize if foreign countries also adopt lead phasedown regulations.

Even with a production decline, given tight energy supplies and projected increases in the demand for gasoline, future lead additives prices should not decline. In 1976, pure TEL sold for about 223.3¢/kilogram. Prices of pure TEL for recent years are presented in Table 2-9.

Table 2-8. U.S. GASOLINE ADDITIVE (Lead Alkyl) MANUFACTURING PLANTS

Company	Plant(s) Location(s)	1974 Capacity (millions of Kg Tetraethyl Lead)
E.I. duPont de Nemours & Company, Inc.	Antioch, California Deepwater, New Jersey	154
Ethyl Corporation	Baton Rouge, Louisiana Pasadena, Texas	177
PPG Industries, Inc.	Beaumont, Texas	54
Nalco Chemical Company	Freeport, Texas	18
		403

Source: Chemical Economics Handbook p. 671.5042 C, December, 1975.

Table 2-9. PRICES OF 100% PURE TETRAETHYL LEAD (TEL) IN TEL MOTOR ANTIKNOCK
(¢/Kg)

1964	124.6
1965	127.9
1966	126.3
1967	125.0
1968	124.1
1969	127.4
1970	128.5
1971	133.6
1972	135.4
1973	137.3
1974	157.6
1975	200.0
1976	223.3

Source: Chemical Economics Handbook, "Tetraethyl Lead and Tetramethyl Lead", Stanford Research Institute, p. 671.5042 R, December 1975, and DuPont, 1976. Antiknock mix prices were multiplied by 1.626 assuming 1.626 pounds of antiknock per pound of pure TEL.

2.5.2 Model Plant Specifications and Dispersion Modeling Results

Of the six gasoline lead additives plants, all are located in flat terrain, 74% of their combined capacity produces tetraethyl lead (TEL) using the sodium-lead alloy process, three are located in Southeast Texas, and the average capacity of each plant is 67,000 metric tons of TEL equivalent. The model plant used in the dispersion modeling is located in flat terrain, produces TEL using the sodium-lead alloy process, has Houston, Texas meteorological conditions, and produces about 54 thousand metric tons of TEL annually.

The model plant is assumed to have lead stack emissions in both the particulate and vapor phases. The lead recovery furnace stack emits lead in the particulate phase and is controlled to the average SIP allowable process weight rate. The process vents and sludge pit exhaust stacks emit lead in the vapor phase and are uncontrolled. No fugitive emissions are assumed. The maximum predicted concentration for the lead stack emissions is 15.7 $\mu g/m^3$, monthly average.

2.5.3 Control Costs

2.5.3.1 Model Plant

Since 15.7 $\mu g/m^3$ is greater than all the considered standards, control costs indicative of reduced stack emission rates are developed for all the considered standards. The costed control system includes packed scrubbers and increased pressure drop on an existing venturi scrubber. The model plant investment, annualized control cost, and investment and annualized cost as a percent of annual revenue are presented

in Table 2-10. Investment control costs for the model plant range from $519 thousand for meeting the 2.0 $\mu g/m^3$ standard to $521 thousand for meeting the 1.0 $\mu g/m^3$ standard. Annualized control cost as a percent of product sales price is about 0.2% for the three considered standards.

2.5.3.2 Industry

A critical factor in the model plant impact assessment is the required reduction in the baseline emission rates to achieve the alternative ambient standards. The required reduction could be greater for larger TEL plants or for TEL plants clustered among other lead emitters. However, to the extent that the required reductions at the six existing gasoline lead additive plants are similar to those at the model plant, achievement of all three alternative ambient standards would appear to be technically possible by all plants. Furthermore, if model plant control costs are related linearly to 1974 production, the estimated 1982 total industry investment costs in this industry are $3.03, $3.03, and $3.05 million for the 2.0, 1.5 and 1.0 $\mu g/m^3$ standards, respectively. The corresponding annualized costs are $1.57, $1.57, and $1.58 million.

2.5.4 Model Plant Closure Assessment

Using a discounted cash flow analysis technique, synthesized model plant process economics, the aforementioned control costs, and assuming no other lead emitters in the vicinity, the potential for closing the model plant on financial grounds is assessed. The model plant process economics are a composite of published financial data for the U.S. gasoline lead additives producers. The major finding of the closure assessment is that the model gasoline lead additives plant is better off remaining open and complying with reduced stack emission rates necessary

Table 2-10. CONTROL COSTS FOR THE MODEL GASOLINE LEAD ADDITIVES PLANT

	Maximum Predicted Ambient Levels ($\mu g/m^3$, monthly average)		
	2.0	1.5	1.0
Investment			
000's of $'s	519	519	521
as a % of annual revenue	0.4%	0.4%	0.4%
Annualized Control Cost			
000's of $'s	270	270	271
as a % of annual revenue	0.2%	0.2%	0.2%

to achieve all standards under a variety of circumstances. These include all marginal tax rate and minimum acceptable return rates thought to be reasonable, fully depreciated plant, sustained production decline (25%), an increase in the raw material lead price (as a result of the lead ambient air quality standard, i.e., 1.8%), and full absorption of all control costs.

2.6 LEAD-ACID BATTERY MANUFACTURING

2.6.1 Industry Structure

Currently there are about 200 lead acid battery manufacturing plants in the United States ranging in size from about 50 to about 11,500 batteries per day.

Two major types of lead acid storage batteries are manufactured in the United States. Starting-Lighting-Ignition (SLI) batteries which are used in auto, aircraft, and golf carts are one type. The units account for more than 80 percent of the market.[22] The second type includes industrial storage batteries for such uses as low-voltage power systems and industrial forklift trucks.

The market for lead-acid storage is composed of three segments. The largest segment in terms of sales is the domestic replacement market. This includes replacement batteries for automobiles, trucks, buses, farm machinery, and heavy equipment. The original domestic equipment market is the second largest segment. This includes batteries sold to producers of new vehicles and equipment. The export sector is the smallest market. This includes replacement batteries in existing equipment and batteries for new equipment. The overall demand for batteries in these market segments is expected to grow between 3.5% and 8.2% per year.[23]

Prices for automobile SLI batteries are about $16 to $22 f.o.b. plant and about $35 to $50 retail.[24] Prices for industrial storage batteries range from $200 to $11,500.[25] Because batteries represent such a small percentage of vehicle costs and appear to have few close

substitutes, demand is thought to be price inelastic. However, the replacement demand market segment for batteries is thought to be less price inelastic than the new demand segment since useful battery life can be extended by improved maintenance, servicing, and repair.

2.6.2 Model Plant Specifications and Dispersion Modeling Results

Two model lead acid battery plants are used in the dispersion modeling. One is capable of producing 500 batteries per day; the other is capable of producing 6500 batteries per day. These two plant sizes are thought to bound the reasonable range of actual industry plant sizes. Consistent with the dispersion model, both plants are located in flat terrain with area meteorological condition data available. This situation is not atypical since there is an actual battery plant with similar terrain and meteorological features.

None of the model lead acid battery plants are assumed to have fugitive emissions. All emissions emanate from point sources. These point sources are controlled to average SIP allowable process weight rates. The maximum predicted concentration for the 500 battery per day plant is 0.9 $\mu g/m^3$, monthly average. The maximum predicted concentration for a 6500 battery per day plant is 7.6 $\mu g/m^3$, monthly average.

2.6.3 Control Cost

Since the maximum predicted concentration for the model 500 battery per day plant does not exceed any of the considered standards, no control costs are developed for that model plant. Control costs are developed for the model 6500 battery per day plant since the maximum predicted concentration

(7.6 $\mu g/m^3$) does exceed the considered standards of 2.0, 1.5, and 1.0 $\mu g/m^3$.

The only point source requiring control is the three process operation stack. Required control efficiencies for this source are about 75 percent, 81 percent, and 88 percent for the respective standards of 2.0, 1.5, and 1.0 $\mu g/m^3$. A wet impingement scrubber is assumed to achieve those control efficiencies at least cost. The investment cost is not assumed to vary with the required control efficiency and is estimated at $130 thousand. Operating costs are, however, assumed affected to some degree by the required control efficiency. Respective annualized costs for meeting 2.0, 1.5, and 1.0 standards are $57,000, $57,400, and $57,900. Annualized cost as a percent of annual revenue (assumes price per battery of $18.50) is about 0.1% for each of three standards.

2.6.4 Model Plant Closure Assessment

A low profit margin fully depreciated model 6500 battery per day plant should be able to absorb the control costs associated with any of the standards and still remain open. This finding holds for a range of marginal tax rates and minimum acceptable return rates thought to be reasonable. It also holds given the assumptions that raw material lead prices increase as a result of the lead ambient air quality standard and that this cost increase (1.8 percent) is absorbed.

Process economics were developed using published financial data for Gould, Inc. and Northwest Industries, Inc.'s General Battery Division.

3.0 OTHER AFFECTED SECTORS

3.1 MOBILE SOURCE ASSESSMENT

Several assumptions are used to project mobile source impact. These include phasedown of lead in the gasoline pool, improved fuel economy, and retirement of some older leaded gasoline using vehicles. For an ambient standard of 2.0 $\mu g/m^3$, one Air Quality Control Region (AQCR) is predicted to require mobile source emission control in 1982. For an ambient standard of 1.5, the number predicted is two AQCRs. And, for an ambient standard of 1.0, it is four AQCRs.

Vehicles using leaded gasoline are retired as they get older, and often these vehicles are replaced with newer cars using unleaded gasoline. Hence, the number of AQCRs requiring mobile source emission control might be less in for example 1985 than in 1982. In 1985, the number of AQCRs requiring mobile source emission control is predicted to be one for the 2.0 and 1.5 $\mu g/m^3$ standards, and two for the 1.0 $\mu g/m^3$ standard.

To achieve the alternative ambient standards in 1982 by retrofitting existing leaded gasoline using light duty vehicles with 75% efficient lead trap mufflers (if available) could affect the following number of vehicles. For the 2.0 $\mu g/m^3$ standard, the predicted number is 58,000. For the 1.5 $\mu g/m^3$ standard, the predicted number is 106,500. And, for 1.0 $\mu g/m^3$ standard the predicted number of light duty vehicles affected is 1,300,000.

Of course retrofitting lead trap mufflers is not the only means of controlling mobile source lead emissions. Reduction in vehicle miles traveled (VMT) and further reduction in the lead content of gasoline are alternatives. VMT reductions can be achieved many ways including

carpooling, mass transit, and reduced trips. Further reduction in the lead content of gasoline can also be achieved in many ways including using non-lead gasoline additives and increasing the reforming capacity of the refineries. Costs for these many ways to achieve alternatives to retrofitting lead trap mufflers have not been developed. Consequently, relative cost effectiveness of retrofitted lead traps is not known.

3.2 STATE AND LOCAL AIR POLLUTION CONTROL AGENCY ASSESSMENT

Currently there are 55 state and 235 local air pollution control agencies. Annually they spend approximately 7100 man-years of effort and $157 million dollars implementing air pollution control regulations.

An ambient lead standard can impose additional requirements (costs) on State and local air pollution control agencies to administer the standard. The added requirements could take the form of more data gathering, enforcement, monitoring, laboratory, support, and management activities. The previously described stationary and mobile source assessments are the bases for estimating these added requirements. To the extent that these bases understate the magnitude of the problem (for example the number of source inspections) the added requirements for State and local control agencies are also understated. But, even if the stationary and mobile source assessments do not understate the magnitude of the problem, control agency requirements could be understated for another reason. The estimates of additional state and local control agency costs do not include the requirements for developing completely new fugitive emissions inventories. However, the estimates do include the requirements for additional maintenance and update of existing inventories.

Some requirements (costs) are estimated to be incurred in the first year only while others are on-going. First year requirements include the costs for ambient monitors and laboratory equipment such as hi-vols and spectrophotometers. In addition, there is non-recurring labor for activities such as State implementation plan development and site preparation for monitors.

No enforcement is assumed to take place during the first year while strategy and regulations are being developed. Also, in the first year monitoring and laboratory activities are limited while equipment is being installed. The first year requirements in dollar terms range from $1.0 million with a standard of 2.0 $\mu g/m^3$, monthly average to $1.7 million with a standard of 1.0 $\mu g/m^3$. The relative magnitudes of these costs compared to current expenditures are 0.6% and 1.0%. In terms of people, the corresponding first year requirements are 30 man-years and 40 man-years. Compared to current man-years expenditures, these correspond to 0.4% and 0.6%, respectively.

On-going or annual costs include operating costs but not depreciation or interest. Examples of operating costs are maintenance, supplies, and power for ambient monitors and laboratory equipment. Operating costs also include a labor component. For example, there are the on-going labor-using activities of mobile and stationary source inspection and enforcement. On-going costs range from $1.4 million with a standard of 2.0 $\mu g/m^3$ to $2.8 million with a standard of 1.0 $\mu g/m^3$. The relative magnitude of these costs are 0.9% and 1.8%. The corresponding man-year requirements are 60 and 120. Compared to current man-year expenditures these correspond to 0.9% and 1.7%, respectively.

First year and on-going costs for the 3 considered standards are presented in Table 3-1.

Table 3-1. STATE AND LOCAL AIR POLLUTION CONTROL AGENCY STANDARDS ADMINISTRATION COST

	Alternative Ambient Standards ($\mu g/m^3$, monthly average)		
	2.0	1.5	1.0
First Year Cost			
000's of $'s	1000	1400	1700
$ Expenditures as a % of current expenditures	.6%	.9%	1.0%
Man year requirements	30	40	40
Man-year requirements as a % of current expenditures	0.4%	0.6%	0.6%
On-Going (Annual Costs)			
000's of $'s	1400	2300	2800
$ Expenditures as a % of current expenditures	0.9%	1.5%	1.8%
Man-year requirements	60	100	120
Man-year requirements as a % of current expenditures	0.9%	1.4%	1.7%

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